PATENT ABSTRACTS OF JAPAN

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(71)Applicant : CITIZEN WATCH CO LTD

(72)Inventor : NAKAMURA SATOKATSU

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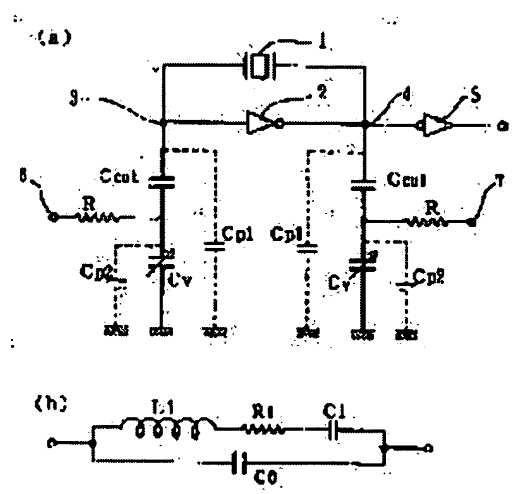
(54) VOLTAGE CONTROLLED CRYSTAL OSCILLATOR

(57)Abstract:

PROBLEM TO BE SOLVED: To present conditions for the circuit constant of an oscillation circuit, with which the variable width of an oscillation frequency can be improved corresponding to the variable width of the capacitance of a variable capacitor, in an integrated voltage controlled crystal oscillator.

SOLUTION: In this voltage controlled crystal oscillator provided with a crystal resonator, an amplifier and a load capacitor provided with a voltage controlled variable capacitor and a capacitor for DC cut integrated on a wafer, the value of a ratio Ccut/Cv of a capacitance Ccut of the capacitor for DC cut to a maximum capacitance Cv of the voltage controlled variable capacitor is made ≥0.5 and ≤10 (1), the value of this ratio is settled within a range of ≥0.5 and ≤4 (2), further, the value of the ratio is settled within a range of ≥0.7 and ≤1.8 (3), moreover, a maximum capacitance Cvmax of the voltage controlled variable capacitor is settled within a range of ≥15 pF and ≤50 pF (4) and further, the voltage controlled variable capacitor is provided on both the input side and the output side of the amplifier (5).



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the crystal oscillator equipped with the variable-capacity component which can control capacity value by the electrical potential difference, in order to adjust an oscillation frequency.
[0002]
[Description of the Prior Art] The oscillation frequency of a quartz resonator is very stable, the temperature characteristic of a quartz resonator is also excellent, and since manufacture of a quartz resonator is also comparatively easy, the ridge oscillator using a quartz resonator is equipped with high practicality. Then, a quartz resonator and an oscillator circuit are unified and the crystal oscillator which can obtain the clock which has a desired frequency only by giving predetermined supply voltage is used widely in recent years.
[0003] In fields, such as telecommunication, when taking the synchronization of two or more signals or synchronizing a system clock with a communication link subcarrier, carrying out adjustable [of the frequency of a crystal oscillator] in a certain range is called for. In order to carry out adjustable [of the oscillation frequency of a crystal oscillator], generally using a variable-capacity component is performed as load-carrying capacity of a quartz resonator. The varicap from which the capacity changes as a variable-capacity component according to the impressed direct current voltage is used. Moreover, the crystal oscillator equipped with such a function is called especially the voltage controlled oscillator.
[0004] Drawing 1 (a) shows an example of the configuration of the conventional armature-voltage control ridge oscillator, and drawing 1 (b) shows 2 terminal equal circuit of a quartz resonator. drawing 1 (a) -- setting -- 1 -- a quartz resonator and 2 -- an inversed amplifier and 3 -- the input terminal of an oscillator circuit, and 4 -- the output terminal of an oscillator circuit, and 5 -- a buffer amplifier, and 6 and 7 -- a control voltage impression terminal and R -- resistance and Cv A variable-capacity component and Ccut The capacitative element for a direct-current cut, and Cp1 and Cp2 show the parasitic capacitance considered, respectively. In addition, although it is required to carry out the seal of approval of the suitable bias voltage for the input terminal 3 of an oscillator circuit in order for this circuit to actually operate, in this Fig., a means to impress this bias voltage shall be included in the inversed amplifier 2. Moreover, it sets to drawing 1 (b) and is C0. L1 C1 and R1 It is the equivalent circuit constant of a quartz resonator, and is C0. Equivalence juxtaposition capacity, L1 An equivalence serial inductance, C1 An equivalence series capacitance, R1 Equivalent series resistance is shown, respectively.
[0005] Drawing 2 is the integrated sectional view for a load part by volume (one side) at the time of IC-izing the armature-voltage control ridge oscillator shown in drawing 1 (a). In drawing 2 , it is the varicap which is the variable-capacity component with which 10 was integrated by the silicon substrate and 11-14 were integrated on the substrate. Moreover, 11 is p which is a low concentration diffusion layer. - A well, p+ field whose 12 is a high concentration diffusion layer, n+ field whose 13 is a high concentration diffusion layer, and 14 are depletion layers. Here, the high concentration diffusion layer 12 serves as ground potential. Moreover, the field oxide by which 15 was formed in the substrate front face, and 16-18 are capacitative elements for a direct-current cut which are integrated on field oxide 15 and have a two-layer polish recon layer. Here, 16, the polish recon film whose 17 is an electrode layer, and 18 are insulating layers. Moreover, 19 is metal wiring, and it has connected also with Resistance R (drawing 1 (a)) while it connects the capacitative element for a direct-current cut, and a variable-capacity component to a serial. In addition, control voltage is impressed to the variable-capacity components 11-14 through Resistance R (drawing 1 (a)) and the metal wiring 19. The depth of a depletion layer 14 changes with the magnitude of this control voltage, and the capacity value (capacity between an n+ field and a p- field) of a variable-capacity component is changed. In addition, the top electrode 17 of a direct-current cut capacitative element is connected with the input terminal 3 (drawing 1 (a)) or the output terminal 4 (drawing 1 (a)) by metal wiring (un-illustrating). Moreover, a broken line 20 is metal wiring in the

reverse connection mentioned later. In reverse connection, it changes to the metal wiring 19 and metal wiring of a broken line 20 is made. Moreover, in reverse connection, the bottom electrode 16 of a direct-current cut capacitative element is connected by metal wiring (un-illustrating) with an input terminal 3 (drawing 1 (a)) or an output terminal 4 (drawing 1 (a)).

[0006]

[Problem(s) to be Solved by the Invention] A voltage controlled oscillator needs to carry out adjustable [of the frequency] in the range which a user demands, securing the stability of an output signal. The frequency adjustable width of face which a user demands changes with applications. Therefore, in order to use a voltage controlled oscillator in common for a broad application, the larger one as much as possible of frequency adjustable width of face is desirable.

[0007] Frequency adjustable width of face has as strong forward correlation as the capacity change width of face of load-carrying capacity. Therefore, it becomes the most important conditions for enlarging frequency adjustable width of face to enlarge capacity change width of face of load-carrying capacity as much as possible. Then, it takes notice of the relation between the capacitative element for a direct-current cut, and a variable-capacity component. The load capacity value of a voltage controlled oscillator turns into capacity value which added together the capacitative element for a direct-current cut and variable-capacity component by which series connection is carried out. Therefore, in order to utilize change of the capacity of a variable-capacity component for the maximum as change of load-carrying capacity, the one where the capacity value of the capacitative element for a direct-current cut which is a fixed value is possible larger is good.

[0008] Before integrating a ridge oscillator, the discrete simple substance component was used for the electrical-potential-difference variable-capacity component and the capacitor for a direct-current cut used as load-carrying capacity. Moreover, the value of each [these] component was able to be freely chosen as other components not related. Therefore, based on the above-mentioned idea, the capacity value Ccut of the capacitor for a direct-current cut was large enough to the maximum capacity value Cvmax of a variable-capacity component, and the value of 10 times or more was usually chosen. And even if integration of a ridge oscillator comes to be tried recently, an above-mentioned idea is followed without being arisen by misgiving, and 10 or more times has been too adopted on a circuit design as a value of Ccut/Cvmax. However, this invention person holds misgiving in this conventional view, and came to search for the room of amelioration of a crystal oscillator.

[0009] The purpose of this invention is showing the circuit-conditions of an oscillator circuit the adjustable width of face of the oscillation frequency to the adjustable width of face of the capacity value of a variable-capacity component being improvable conventionally in the crystal oscillator constituted using the integrated ridge oscillator. It is showing the range of the value of Ccut/Cvmax where the purpose of this invention can enlarge adjustable width of face of an oscillation frequency at a detail, and the effective circuit conditions for enlarging adjustable width of face of an oscillation frequency further more.

[0010]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the voltage controlled oscillator of this invention is equipped with the following description.

(1) the capacitative element for a direct-current cut which are a quartz resonator, amplifier, and the voltage controlled oscillator that has load-carrying capacity and by which series connection of the load-carrying capacity was carried out to the armature-voltage control variable-capacity component and armature-voltage control variable-capacity component which were integrated on the semi-conductor substrate -- containing -- the ratio of the maximum capacity value Cvmax of an armature-voltage control variable-capacity component, and the capacity value Ccut of the capacitative element for a direct-current cut -- the value of Ccut/Cvmax is smaller than 0.5 or more and 10.

[0011] Furthermore, as for the voltage controlled oscillator of this invention, it is desirable to have the following descriptions.

(2) a ratio -- having made the value of Ccut/Cvmax into 0.5 or more and 4 or less range.

(3) a ratio -- having made the value of Ccut/Cvmax into 0.7 or more and 1.8 or less range.

(4) The maximum capacity value Cvmax of an armature-voltage control variable-capacity component was made into the range of 15pF or more and 50pF or less.

(5) The armature-voltage control variable-capacity component should be prepared in the input side of amplifier, and the both sides of an output side.

[0012]

[Embodiment of the Invention] The integrated electrode layer (polish recon film 16 of drawing 2) of the capacitative element for a direct-current cut surely has parasitic capacitance (stray capacity) Cp2 to a semi-conductor substrate, and the value is proportional to the occupancy area of an electrode layer mostly. Then, for this invention person, when it

designs so that the capacity value of the capacitative element for a direct-current cut may become large, the parasitic capacitance Cp2 which is a big fixed capacity is the variable-capacity component Cv. It will be formed in juxtaposition and I thought that the frequency change effectiveness of a variable-capacity component was probably reduced on the contrary. Furthermore, there is a phenomenon in which the variation (how to the frequency of a capacity good variate to be effective) of a frequency to the variation of load-carrying capacity becomes small, so that load-carrying capacity becomes large. Therefore, if magnitude of the capacitative element for a direct-current cut is made smaller than the conventional example and it suppresses generating of parasitic capacitance in integrating, it can be surmised that the outstanding effectiveness that the frequency change effectiveness serves as size is demonstrated.

[0013] Then, the formula which expresses change of an oscillation frequency first has been grasped clearly. Next, simulation was performed, changing the various circuit constants of an oscillator circuit based on the formula showing change of an oscillation frequency. In simulation, it asked for the adjustable width of face of an oscillation frequency by numerical calculation. The formula first used for below is hung up. In addition, in the gestalt of operation of this invention, the oscillator circuit used what was shown in drawing 1 using what showed the structure of the integrated capacitative element for a direct-current cut, and an armature-voltage control variable-capacity component to drawing 2 .

[0014] Change of the oscillation frequency in a voltage controlled oscillator is expressed by the formula (1), and the value of load-carrying capacity is expressed by the formula (2).

deltaf/fS =1+C0 /[2gamma (C0 +CL)] .... (1)

2CLs = Cp1 +Ccut x(valve flow coefficient +Cp2)/(Ccut +valve flow coefficient +Cp2) .... (2)

It corrects. fS The series resonating frequency of a quartz resonator, CL Load-carrying capacity and deltaf/fS express frequency rate of change.

[0015] The circuit constant considered to be standard in simulation is set up as a certified value, one of each of the constant is changed before and after a certified value, and it is based on a formula (2) and a formula (1), and is load-carrying capacity and frequency rate-of-change deltaf/fs. It calculated. Moreover, it is Ccut to an axis of abscissa. In 1-12 showed the value of the ratio of /Cv, and to the axis of ordinate, frequency adjustable width of face (difference of deltaf/fs in Cvmax and deltaf/fs in Cmini) was expressed per ppm, and was graph-ized on it. Moreover, the circuit constant which others changed was taken as the parameter.

[0016] In addition, the oscillator circuit of drawing 1 (a) is Cv to the both sides of an input side and an output side. Ccut It has. Especially in the following simulation, except for drawing 11 and drawing 12 which examined the asymmetry of a circuit, it shall have the structure and the property of both sides (an input side and output side) that load-carrying capacity is the same, and the variable capacity of both sides shall be changed to full. In addition, each constant is Cvmax=30pF, Cvmin=3pF, 1= 3pF of Cp(s), and Cp2=Ccut. 7%, C0 = the case of 3pF and gamma(C0/C1) = 280 was made into standard conditions.

[0017] The result of simulation is illustrated below. In addition, it omits describing each count. At least one of the curves of each drawing is the curve of the above-mentioned standard conditions.

[0018] Drawing 3 is the graph with which the maximum capacity value Cvmax of a variable-capacity component was expressed for the relation between frequency adjustable width of face (ppm) and Ccut/Cvmax as a parameter. In drawing 3 , the maximum capacity value Cvmax of a variable-capacity component is changed to five kinds. In addition, the minimum capacity value Cvmin was set to 10% of each Cvmax. Moreover, the peak of each curve is connected with a dotted line, and change of the location is also shown. The same is said of each following drawing.

[0019] As shown in drawing 3 , even if Cvmax changes, a curved form changes [in / no / a curve] a lot. Moreover, in every curve, Ccut/Cvmax used conventionally is a value with very small frequency adjustable width of face or more in ten. And the range of Ccut/Cvmax of the peak of the frequency adjustable width of face of each curve is 0.8-1.6, and this is the range of a small value which had not carried out anticipation conventionally, either.

[0020] Drawing 4 is the graph with which the maximum capacity value Cvmax of a variable-capacity component was expressed for the relation between frequency adjustable width of face (ppm) and Ccut/Cvmax as a parameter like drawing 3 . However, Cvmin is taken as the constant value of 3pF. As shown in drawing 4 , even if Cvmax changes, a curved form changes [in / no / a curve] a lot. Moreover, as for the peak of the frequency adjustable width of face of each curve, Ccut/Cvmax has appeared in 0.7-1.7. It is characteristic that an inversion takes place to the value of frequency adjustable width of face between what has the large value of Cvmax, and a small thing as the value of Ccut/Cvmax increases in this Fig. This is a good example which tells how the effect of parasitic capacitance Cp2 is large to frequency adjustable width of face.

[0021] Drawing 5 is the graph with which the minimum capacity value Cvmin of a variable-capacity component was expressed for the relation between frequency adjustable width of face (ppm) and Ccut/Cvmax as a parameter. However, Cvmax considers as the constant value of 30pF, and is changing Cvmin in 2-5pF. In drawing 5 , each curve

has the form where it gathered well, and there is also little migration of the peak location on an axis of abscissa. Moreover, as for the peak of the frequency adjustable width of face of each curve, Ccut/Cvmax has appeared in 1.1-1.4.

[0022] Drawing 6 is the graph with which parasitic capacitance Cp1 was expressed for the relation between frequency adjustable width of face (ppm) and Ccut/Cvmax as a parameter. However, parasitic capacitance Cp1 is changed among 2-5pF. Parasitic capacitance Cp1 adds together the gate capacitance of amplifier, the connection pad of a quartz resonator, the stray capacity of wiring, etc., and is Ccut. Cv Since a series capacitance is bypassed, it works so that frequency adjustable width of face may be reduced. Moreover, as for the peak of the frequency adjustable width of face of each curve, Ccut/Cvmax has appeared in 1.1-1.4.

[0023] Drawing 7 is the graph with which parasitic capacitance Cp2 was expressed for the relation between frequency adjustable width of face (ppm) and Ccut/Cvmax as a parameter. However, parasitic capacitance Cp2 is the capacity Ccut for a direct-current cut. It is made to change in 5% - 9% of range. As parasitic capacitance Cp2 is shown in drawing 2 , the capacity between the electrode of Ccut and a silicon substrate 10 is a subject. Therefore, if the cross-section structure of IC is the same, it is proportional to the electrode surface product of Ccut. Moreover, since Cp2 bypasses Cv directly, its effect of the form on curved is large. As for the peak of the frequency adjustable width of face of each curve, Ccut/Cvmax has appeared in 1.0-1.3. The place where the value of Ccut/Cvmax of the effect of Cp2 is larger appears greatly (namely, when Ccut is large). That is, especially when [of the value of Ccut/Cvmax] large, the reduction effectiveness of the absolute value of frequency adjustable width of face is large, and it turns out in the range (the value of Ccut/Cvmax is ten or more) of the conventional example that it had the in fact very big influence of negative.

[0024] Drawing 8 is the graph with which gamma was expressed for the relation between frequency adjustable width of face (ppm) and Ccut/Cvmax as a parameter. gamma is the ratio of the juxtaposition capacity C0 to the equivalence series capacitance C1 of a quartz resonator. The form of each curve resembles the form of the curve in other drawings well. Moreover, Ccut/Cvmax is 1.17 and the peak of the frequency adjustable width of face of each curve has it to gamma (receiving change of C1 in fact in this example, since C0 is fixed). [eternal]

[0025] Drawing 9 is the graph with which the juxtaposition capacity C0 was expressed for the relation between frequency adjustable width of face (ppm) and Ccut/Cvmax as a parameter. The form of each curve resembles the form of the curve in other drawings well. The configuration of each curve and the peak location bear a strong resemblance to other drawings. As for the peak of the frequency adjustable width of face of each curve, Ccut/Cvmax has appeared in 0.9-1.3.

[0026] Drawing 10 is the graph with which Cp3 was expressed for the relation between frequency adjustable width of face (ppm) and Ccut/Cvmax as a parameter. However, Cp3 shows only two kinds, the case of 1pF, and the case of 0pF. Cp3 is defined as being the fixed (that is, it not being proportional to Ccut) parasitic capacitance added to juxtaposition in the same location as Cp2 of drawing 1 (a), and a subject is slight stray capacity produced in wiring between Ccut-Cv-R. Although frequency adjustable width of face is reduced of course when Cp3 is considered, the reduction width of face is slight, and does not have big effect on a curved form.

[0027] Drawing 11 is a graph [standard conditions / case / where the maximum capacity value of a variable-capacity component prepared in the input side and output side of an oscillator circuit is changed] (when Cvmax of the variable-capacity component of both sides is set [both] to 30pF). They could be one Cvmax=40pF and Cvmax=20pF of another side then. Although the curved upper and lower sides interchange that an I/O side is unsymmetrical bordering on the Ccut/Cvmax=2.7 neighborhood as a result, most differences of a curved configuration are not accepted.

[0028] Drawing 12 is a graph [standard conditions / case / where prepared the variable-capacity component in either the input side of an oscillator circuit, or the output side, and another side is used as a fixed capacitative element] (when a variable-capacity component is prepared in both sides). One variable-capacity component set standard conditions, and the same and the fixed capacitative element of another side to 10pF. When a variable-capacity component is prepared only in one side, the absolute value of frequency adjustable width of face is reduced by half. However, the location of the configuration of the curve at the time of preparing a variable-capacity component only in one side and a curved peak is similar with the preparing-in both sides-variable-capacity component case. Here, simulation was performed about the case where a variable-capacity component is prepared only in one side for a comparison. However, when integrating for one chip and creating an oscillator, even if it prepares a variable-capacity component only in one side, components mark are not necessarily reduced. Therefore, it is thought that the circuitry which prepared the variable-capacity component only in one side with narrow frequency adjustable width of face is not almost used in fact.

[0029] Drawing 13 is the graph which compared the case of reverse connection with the case of standard conditions. Instead of the metal wiring 19 (refer to drawing 2), reverse connection is the metal wiring 20 (a broken line shows to

drawing 2), and means the case where the polish recon film 17 is connected. Moreover, the certified value is used for other circuit elements. Furthermore, CL in this example It is expressed with the following (3) types instead of (2) types. In addition, standard conditions (order connection) are the metal wiring 19, and mean the case where the polish recon film 16 is connected. As shown in drawing 13 , most both curves lapped and there was no substantial (the curve of a reverse connection case is located in the bottom by only mere a few) difference. It has been the example a Ccut/Cvmax ratio with this effective indicates it to be to seldom be influenced by the structure of an oscillator circuit IC.

2CLs =(valve flow coefficient xCout)/(valve flow coefficient +Cout)+Cp1+Cp2 ...... (3)

[0030] The result of simulation is described very bird's-eye.

(1) Although the configuration of each curve is different about frequency change width of face, it is mutually similar and a unique configuration does not appear.

(2) In the case of a value with the value of Ccut/Cvmax quite smaller than ten or more [which was used conventionally] (however, the case where the value of Ccut/Cvmax is smaller than about 0.3 is removed), frequency adjustable width of face improves more remarkably than before.

(3) As for the peak of the frequency adjustable width of face of each curve, the value of Ccut/Cvmax appears in about 0.7 to 1.8 range.

[0031] When reference frequency doubles and all general conditions, such as lump deflection and frequency deviation by temperature, are taken into consideration, the industry standard of the frequency stability of a crystal oscillator is **50 ppm. Therefore, also at the lowest except for the case of being special, an electrical-potential-difference variable crystal oscillator must secure frequency adjustable width of face of 100 ppm or more. When a simulation result is considered bearing this in mind, if the value of Ccut/Cvmax is smaller than 0.2 or more and 10, it turns out that the above-mentioned minimum requirement is fulfilled.

[0032] However, even if it is this range, the part with the extremely small value of a ratio is not suitable for an actual product. It is because it is necessary to expect the variation in a constant rate to the capacity value in an actual product and change of the good variate of a part with the extremely small value of a ratio is too steep to this variation. If this is taken into consideration, 0.5 or more [whose variation of adjustable width of face is not not much steep] are suitable for the value of the ratio of Ccut/Cvmax.

[0033] After securing stability of an oscillator own [above-mentioned], whether it is the need changes in what frequency adjustable width of face with each applications, but if frequency adjustable width of face is **100 ppm or more, it will be considered by almost all existing applications that it can be adapted. Therefore, frequency adjustable width of face of **100 ppm or more is one certified value in a voltage controlled oscillator. In each graph, he can understand that the range of the value of Ccut/Cvmax which can secure frequency adjustable width of face of 200 ppm or more is 0.4-4.0. However, 0.5 or more are suitable at the reason same with having mentioned above as a lower limit.

[0034] When the value of Ccut/Cvmax is set up near the peak value of the curve in each graph, it is still more possible to obtain the frequency adjustable width of face exceeding 250 ppm. As for the peak of the curve in each graph, it turns out that the value of Ccut/Cvmax has appeared altogether in the range of 0.7-1.8. Moreover, in every graph, within the limits of the above-mentioned ratio, he has secured frequency adjustable width of face of 250 ppm or more, and can understand that they are the optimal conditions for obtaining large frequency adjustable width of face.

[0035] Conventionally, since only discrete part constituted the voltage controlled oscillator with such large frequency adjustable width of face, in order that an appearance might use special components and circuitry greatly, it was expensive. According to this invention with a deer, it becomes possible to offer the voltage controlled oscillator which had large frequency adjustable width of face by small and the low price.

[0036] It can be said that it is very effective to choose the thing of the range mentioned above as a value of Ccut/Cvmax in actually designing and manufacturing an integrated circuit since the thing of the range considered that the value of each parameter is acquired standardly in this simulation is used in order to obtain large frequency adjustable width of face.

[0037] Although differing from what frequency adjustable width of face and the peak value of the ratio of Ccut/Cvmax mentioned above is also considered when the numeric value out of range chosen to each parameter this time is inputted Considering that the form of the curve in each drawing is very alike in this simulation, and a specific curve does not exist Even in such a case, in order that choosing the range of the value of Ccut/Cvmax mentioned above may secure large frequency adjustable width of face, an effective thing does not have a change.

[0038] Moreover, in this simulation, in order to avoid that explanation becomes complicated, only the value of a single parameter is changed altogether. Although differing from what frequency adjustable width of face and the peak value of the ratio of Ccut/Cvmax mentioned above is also considered when changing two or more parameters from a certified

value Considering that the form of the curve in each drawing is very alike in this simulation, and a specific curve does not exist Even in such a case, in order that choosing the range of the value of Ccut/Cvmax mentioned above may secure large frequency adjustable width of face, an effective thing does not have a change.

[0039] Since the parameter (value of Cvmax when fixing Ccut/Cvmax) of the graph of drawing 3 can be adjusted only in the area of a variable-capacity component and a direct-current cut capacitative element, unlike other parameters, it can take any value. However, since big frequency adjustable width of face cannot be obtained in peak value in any values other than the range shown by drawing 3 (not shown), the value of Cvmax has the desirable range of 15pF - 50pF shown in drawing 3 .

[0040] In addition, when the actual integrated circuit (test chip) which shook conditions variously on the basis of the circuit of drawing 1 (a) was made and frequency adjustable width of face was measured, the result which is very well in agreement with the above-mentioned simulation was obtained.

[0041] Other examples of structure of a different variable-capacity component from drawing 2 are shown in drawing 14 . In addition, drawing 14 shows the sectional view of IC structure of a variable-capacity component part. In drawing 14 , although a variable-capacity component is varicap, the silicon substrate 10 was written as p substrate, and the well is lost.

[0042] The example of structure of further others of a variable-capacity component is shown in drawing 15 . In drawing 15 , a variable-capacity component is not varicap but a component called MOS-C, and uses the gate capacitance of an MOS transistor as variable capacity. In drawing 15 , 21 is an oxide film and 22 is an electrode layer. Although n substrate is used for drawing 15 , it can also consist of p substrates.

[0043] In addition, also in the example shown in drawing 14 and drawing 15 , the capacitative element for a direct-current cut is required, and parasitic capacitance follows it on it. Therefore, it is clear for this invention to be applied also to the example shown in drawing 14 and drawing 15 .

[0044] Although the gestalt of operation of this invention was described above, the certified value of the circuit constant in this invention and the equivalent circuit constant of a quartz resonator is not limited to what was illustrated. Moreover, it is not limited to what also not necessarily showed target configuration of a circuit and structure of an integrated circuit to drawing 1 and drawing 2 . For example, there is a quartz resonator which has various kinds of cuts, an oscillating style, or a two or more-terminal terminal, and the optimal oscillator circuit corresponding to them exists. This invention is fundamentally applicable to the oscillator circuit of a configuration of controlling an oscillation frequency by electrical-potential-difference change of load-carrying capacity. Furthermore, since the vibrator which consists of piezo-electric material other than Xtal can also be expressed in an equal circuit as shown in drawing 1 (b), it can be permuted by the quartz resonator of this invention.

[0045]

[Effect of the Invention] (1) In the voltage controlled oscillator of this invention, frequency adjustable width of face larger than before was able to be obtained by making capacity value of the integrated capacitative element for a direct-current cut into a value smaller than before. Therefore, the voltage controlled oscillator of this invention became possible [using it to more application]. Furthermore, since the voltage controlled oscillator of this invention can stop small the occupancy area on the integrated circuit of the capacitative element for a direct-current cut, when manufacturing the crystal oscillator containing a quartz resonator, and when carrying out rigging, it has a very large advantage.

[0046] In the voltage controlled oscillator of this invention, by making the value of (2) Ccut/Cvmax into the range of 0.5-4, even when conditions are bad, it becomes possible to obtain the frequency adjustable width of face exceeding 200 ppm. Moreover, by making the value of (3) Ccut/Cvmax into the range of 0.7-1.8, the value near the peak value or peak value of frequency adjustable width of face is acquired certainly, and the frequency adjustable design top greatest width of face can be obtained. Furthermore, it becomes possible by making (4) Cvmax into the range of 15-50pF to secure big frequency adjustable width of face.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] the capacitative element for a direct-current cut which is the voltage controlled oscillator which has a quartz resonator, amplifier, and load-carrying capacity and by which series connection of said load-carrying capacity was carried out to the armature-voltage control variable-capacity component integrated on the semi-conductor substrate, and said armature-voltage control variable-capacity component -- containing -- the ratio of the maximum capacity value Cvmax of an armature-voltage control variable-capacity component, and the capacity value Ccut of said capacitative element for a direct-current cut -- the voltage controlled oscillator characterized by Ccut/Cvmax being smaller than 0.5 or more and 10.
[Claim 2] Aforementioned ratio Ccut/Cvmax is the voltage controlled oscillator of claim 1 characterized by being 0.5 or more and 4 or less.
[Claim 3] Aforementioned ratio Ccut/Cvmax is the voltage controlled oscillator of claim 1 characterized by being 0.7 or more and 1.8 or less.
[Claim 4] The maximum capacity value Cvmax of said armature-voltage control variable-capacity component is the voltage controlled oscillator of claim 1 characterized by being 15pF or more and 50pF or less thru/or either of 3.
[Claim 5] Said armature-voltage control variable-capacity component is the voltage controlled oscillator of claim 1 characterized by being prepared in the input side of said amplifier, and the both sides of an output side thru/or either of 3.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] (a) shows an example of the ridge oscillator used also in the operation gestalt of this invention, and (b) shows 2 terminal equal circuit of a quartz resonator.
[Drawing 2] An example of the sectional view for a load part by volume in the integrated ridge oscillator which is used also in the operation gestalt of this invention is shown.
[Drawing 3] a ratio -- it is a graph showing change of the frequency adjustable width of face of the ridge oscillator to Ccut/Cvmax, and magnitude of a variable-capacity component is made into a parameter, and the ratio of the maximum Cmax of variable capacity and the minimum value Cmin is set constant.
[Drawing 4] a ratio -- it is a graph showing change of the frequency adjustable width of face of the ridge oscillator to a Ccut/Cvmax ratio, and magnitude of a variable-capacity component is made into a parameter, and the minimum value Cmin of variable capacity is set constant.
[Drawing 5] a ratio -- the graph showing change of the frequency adjustable width of face of the ridge oscillator to Ccut/Cvmax -- it is -- the minimum value Cmin of variable capacity Let magnitude be a parameter.
[Drawing 6] a ratio -- it is a graph showing change of the frequency adjustable width of face of the ridge oscillator to Ccut/Cvmax, and let magnitude of parasitic capacitance Cp1 be a parameter.
[Drawing 7] a ratio -- it is a graph showing change of the frequency adjustable width of face of the ridge oscillator to Ccut/Cvmax, and let magnitude of parasitic capacitance Cp2 be a parameter.
[Drawing 8] a ratio -- the ratio [as opposed to / are a graph and / the equivalence series capacitance of a quartz resonator] showing change of the frequency adjustable width of face of the ridge oscillator to Ccut/Cvmax of juxtaposition capacity -- let magnitude of gamma be a parameter.
[Drawing 9] a ratio -- the graph showing change of the frequency adjustable width of face of the ridge oscillator to Ccut/Cvmax -- it is -- juxtaposition capacity C0 of a quartz resonator Let magnitude be a parameter.
[Drawing 10] a ratio -- the graph showing change of the frequency adjustable width of face of the ridge oscillator to Ccut/Cvmax compares the existence of the fixed parasitic capacitance Cp3 resulting from wiring.
[Drawing 11] a ratio -- the graph showing change of the frequency adjustable width of face of the ridge oscillator to Ccut/Cvmax shows the case where the magnitude of the variable capacity by the side of I/O of an oscillator circuit differs.
[Drawing 12] a ratio -- the case where a variable-capacity component is prepared for the case where it prepares only in one side by the side of I/O of an oscillator circuit, and both sides, in the graph showing change of the frequency adjustable width of face of the ridge oscillator to Ccut/Cvmax is compared.
[Drawing 13] a ratio -- the case where a variable-capacity component is connected to the electrode side with which the capacitative elements for a direct-current cut differ in the graph showing change of the frequency adjustable width of face of the ridge oscillator to Ccut/Cvmax is compared.
[Drawing 14] It is the sectional view of other examples for a load part by volume in the integrated ridge oscillator which can be used also in an example of the gestalt of operation of this invention.
[Drawing 15] It is the sectional view of the example of further others for a load part by volume in the integrated ridge oscillator which can be used also in an example of the gestalt of operation of this invention.
[Description of Notations]
1 Quartz Resonator
2 Amplifier
3 Input Terminal
4 Output Terminal
5 Buffer Amplifier

6 Seven Control voltage impression terminal
R Input resistance
Cv Variable-capacity component
Ccut Capacitative element for a direct-current cut
Cp1, Cp2 Parasitic capacitance
C0, L1, C1, R1 Equivalent circuit constant of a quartz resonator
C0 Juxtaposition capacity
L1 Equivalence serial inductance
C1 Equivalence series capacitance
R1 Equivalent series resistance
10 Silicon Substrate
11, 12, 13, 14 Variable-capacity component
11 P - Well
12 P+ Field
13 N+ Field
14 Depletion Layer
15 Field Oxide
16, 17, 18 Capacitative element for a direct-current cut
16 17 Polish recon film
18 Insulating Layer
19 Metal Wiring
21 Oxide Film
22 Electrode Layer

[Translation done.]

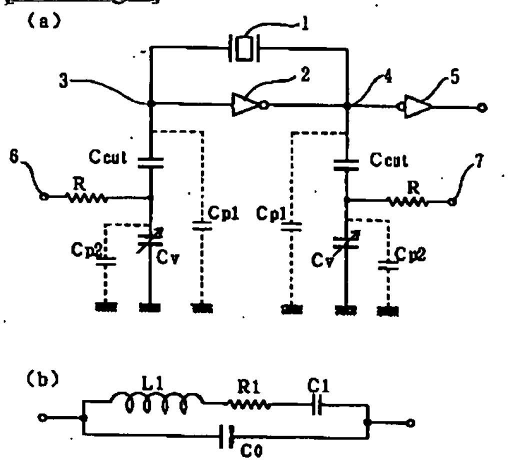
* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

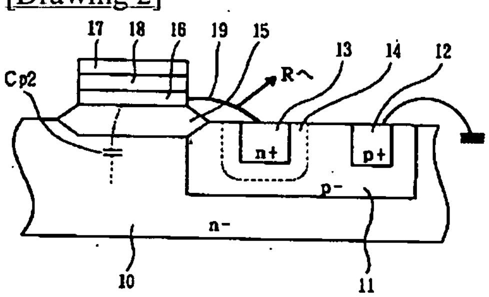
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

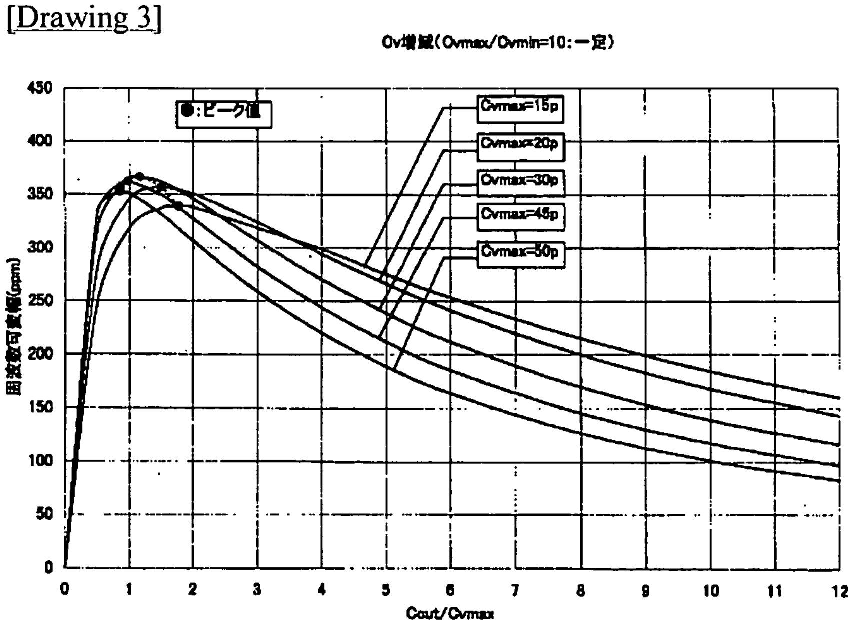
[Drawing 1]



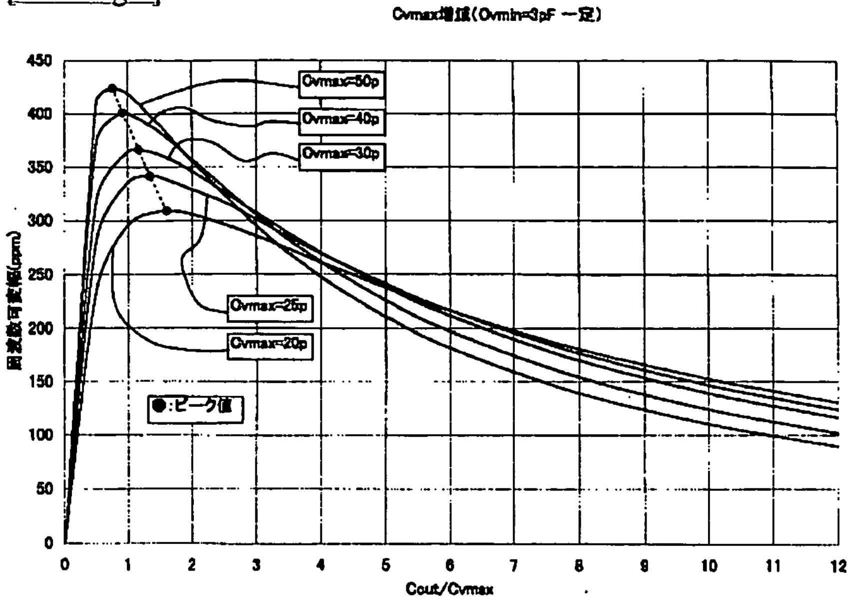
[Drawing 2]



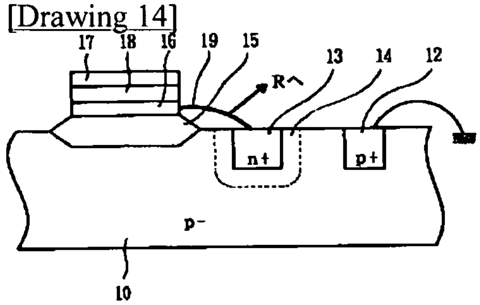
[Drawing 3]



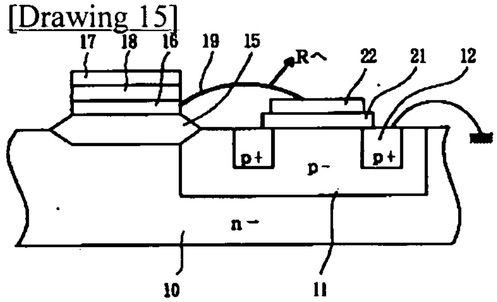
[Drawing 4]



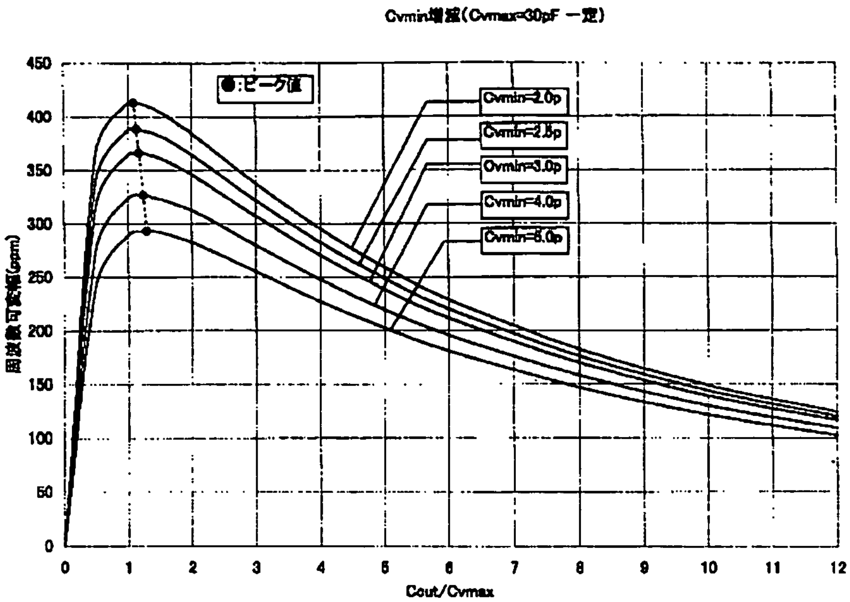
[Drawing 14]



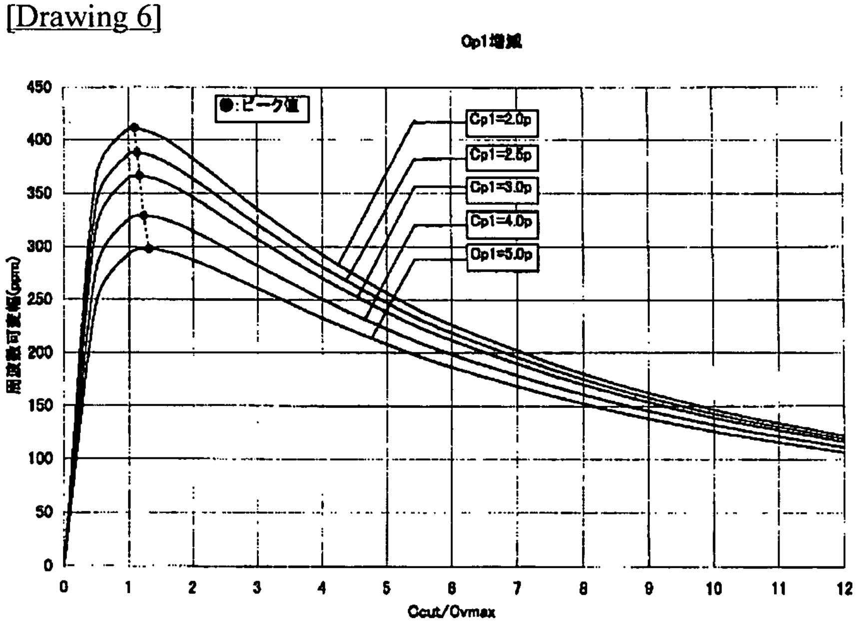
[Drawing 15]



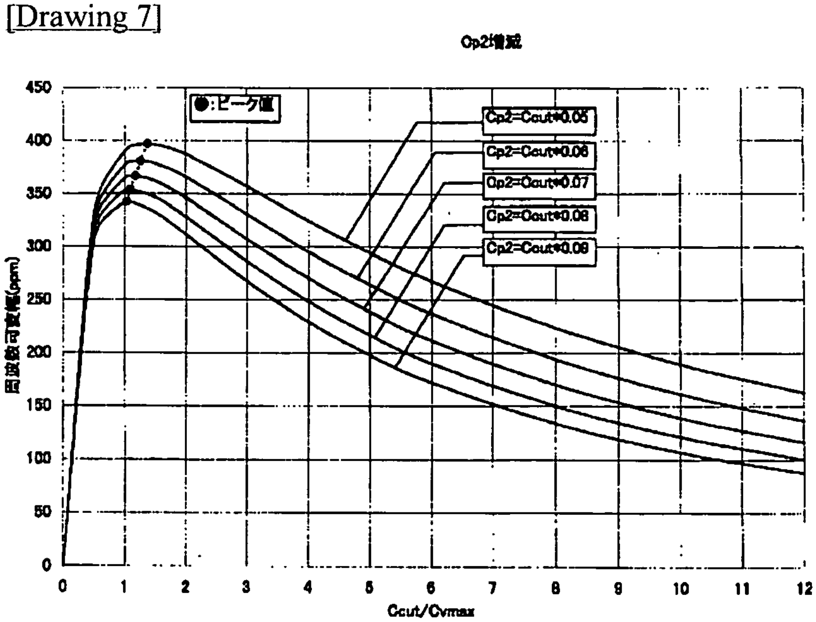
[Drawing 5]



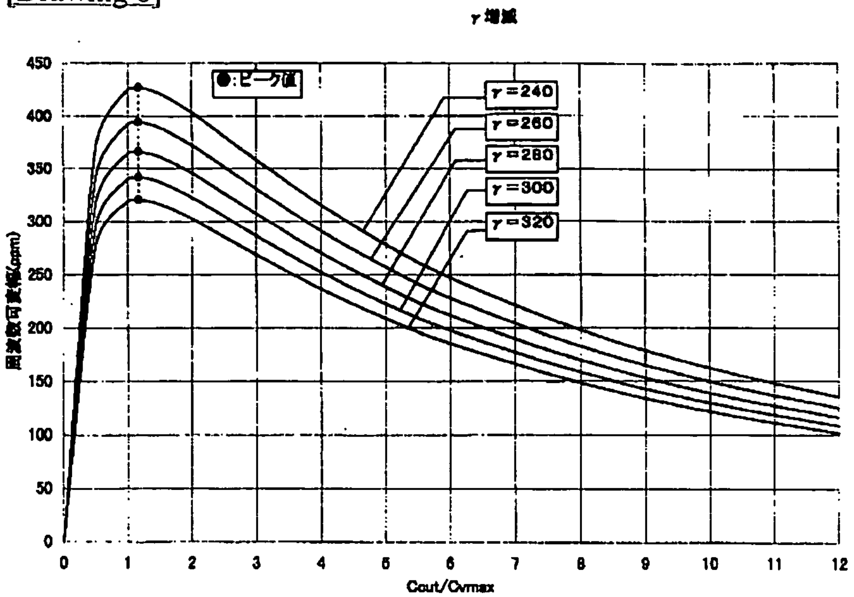
[Drawing 6]



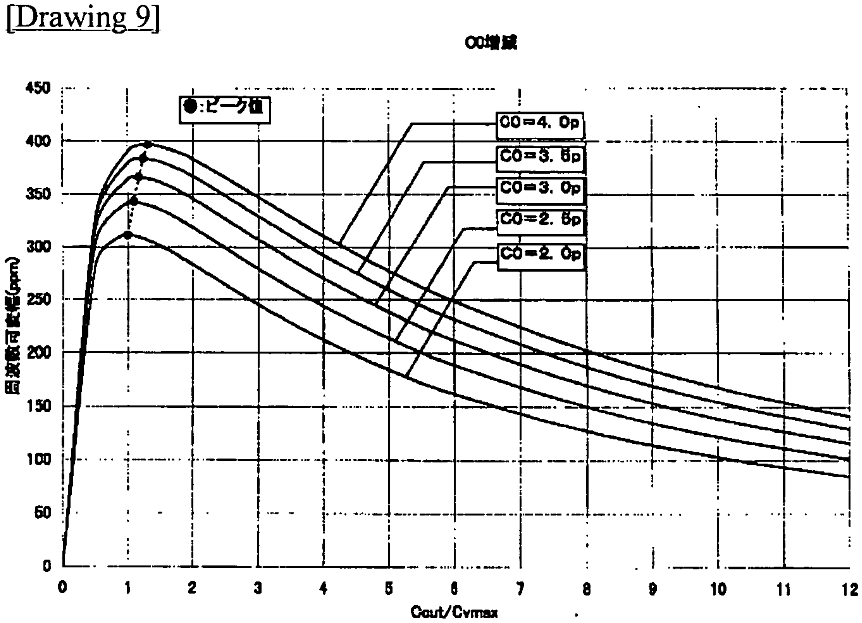
[Drawing 7]



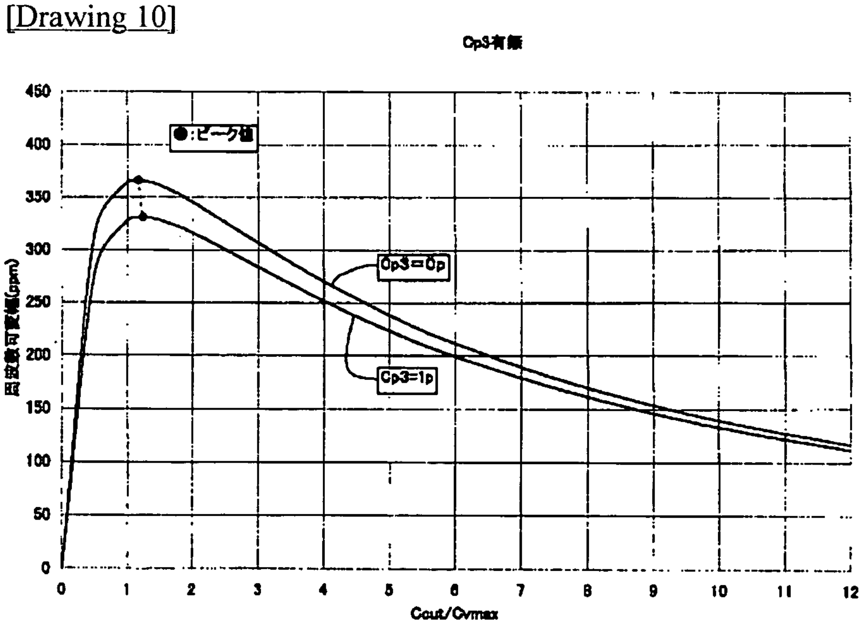
[Drawing 8]



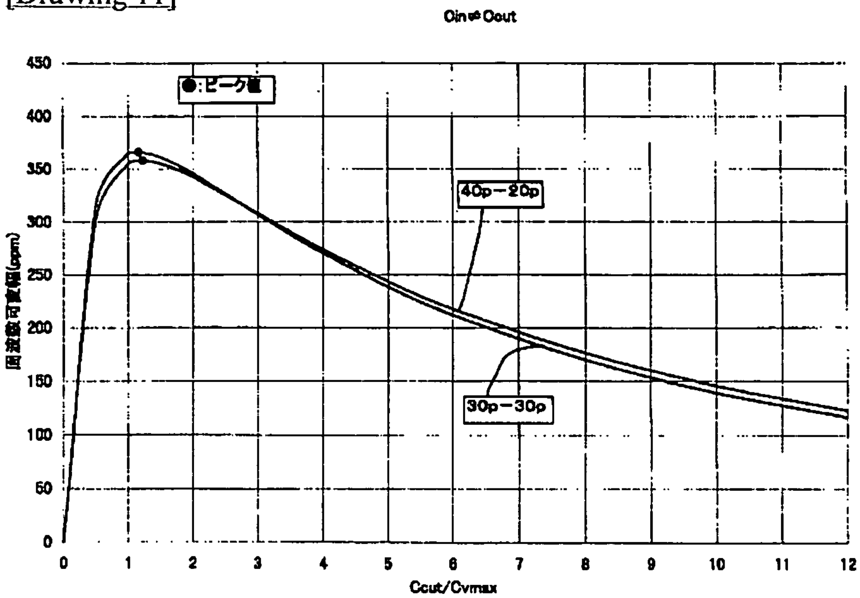
[Drawing 9]



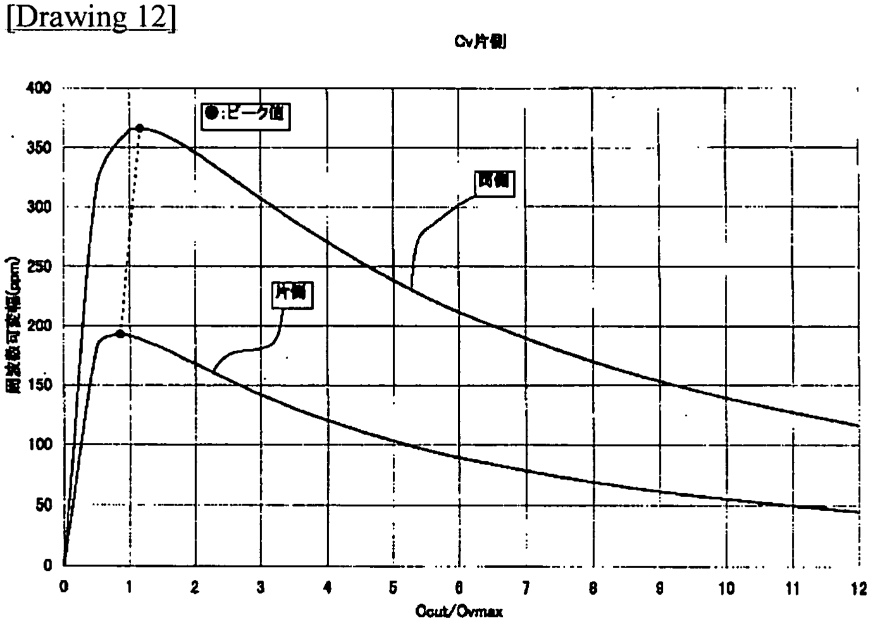
[Drawing 10]



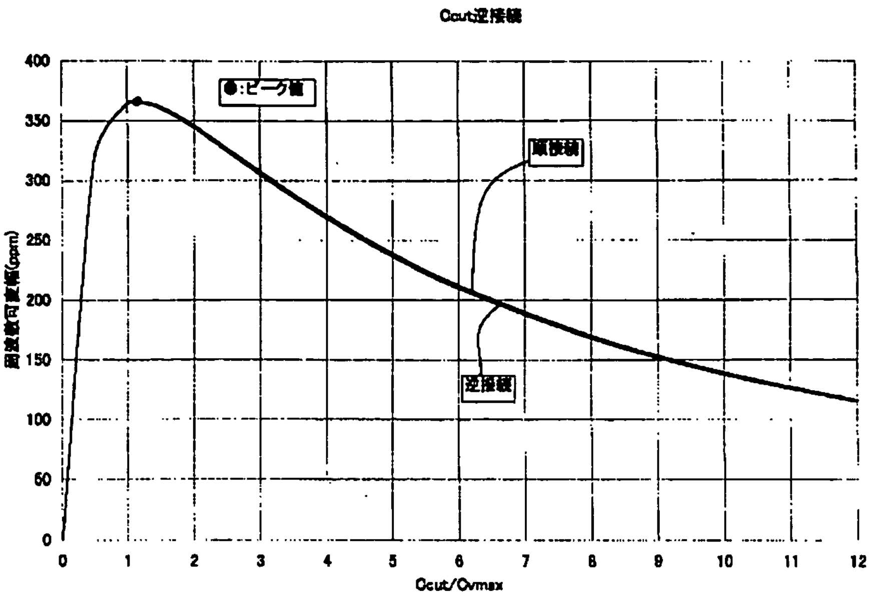
[Drawing 11]



[Drawing 12]



[Drawing 13]



[Translation done.]